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POSTERIOR COLUMN DEGENERATIONS FOLLOWING INJURY TO THE POSTERIOR ROOTS OF THE SEVENTH CERVICAL NERVES

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It is always of value to add to the literature of the anatomy of the nervous system those cases of well-defined lesions which can be studied by the method of Marchi, and which bear on the unsettled problems of localization and fiber relations.

The following contribution is a study of the degenerations of the posterior columns of the spinal cord, resulting from an injury to the posterior roots of the seventh cervical nerves.

The material for the study came from a patient of the Danvers Insane Hospital, who was admitted there, into the service of one of us, Mitchell, in November, 1905, and died twelve days later. The patient was a man aged 47, who for ten years previous to his admission had been a hard drinker and, unable to hold any position, had led a vagabond life, and on two occasions had been an inmate of the Foxboro institution. When about 45 years of age he had a convulsion, while intoxicated, and last April had an attack of delirium tremens. During the night of October 26, while sleeping in a hay mow with drunken companions, he fell some distance to the floor and on the following morning was picked up in an unconscious condition by his companions. Later in the day he walked some distance to a friend's place of business, where he spent the day and night. He complained of feeling badly and it was observed that his head was turned to the side and bent in a peculiar position. On the day following he walked about two miles to a physician's office. His arms were then weak, he was unable to feed himself and it was difficult for him to rise from a chair. He was sent to a hospital and on November 1 was admitted to the Danvers Insane Hospital.

A summary of the physical examination made on the day following showed that he had a temperature of 102, pulse 98, respiration 30. As he lay in bed his head was turned to the right and drooped towards the shoulder. Save for a slight harsh systolic murmur, examination of the chest gave nothing important. The bladder was distended and there was a constant dribbling of urine. The urine had a trace of albumin.

The neurological examination showed that there was marked paralysis of the arms and legs. The right arm was held stiffly in a flexed position and could only be raised a few inches. The left arm was even more helpless. The legs could not be moved voluntarily. There was some twitching of the muscles of the right leg. Attempts to correct the position of his head caused pain which he referred to the back of his neck. Eye movements were not impaired, more than that there was a slight nystagmus on forced movements. Pupils were equal and reacted to light stimuli. Arm and knee jerks were not obtained. Cremaster and plantar reflexes present. No Babinski reflex. There was no control of bladder or bowel. Electrical reactions were not abnormal. Subjectively, he complained of prickly feelings in both arms and legs. His reaction to sensory stimuli was diminished over the entire body. Pressure over nerve trunks was not painful. He appreciated difference in pressure, but differentiated very poorly between sharp and dull points. He made many mistakes in recognizing between heat and cold. Position sense was not impaired. No astereognosis.

At this time his mental attitude was not peculiar except that his memory was uncertain for the events of the previous ten days. On the day following his temperature rose to 103 and he began to have visual hallucinations, imagining that he saw a bottle in his bed. His grasp on questions became unclear, he was dull, and it took stronger stimuli than normal to gain his attention. A few days later he developed bed sores, and the urine gave evidences of a severe degree of cystitis. By November 10 he had failed much. His stupor was more marked and his speech was difficult and his tones feeble. The right arm could be stirred a little, but otherwise all voluntary movements were absent in arms and legs. Below the level of the second rib, excepting for the outer surface of both arms, pin pricks produced no pain reaction (Fig. 1). Over the arms he recognized light touches and appreciated difference in pressure. With temperature tests he made many mistakes. The tendon reflexes remained absent. Swallowing became more difficult, and on November 12 he died in coma.

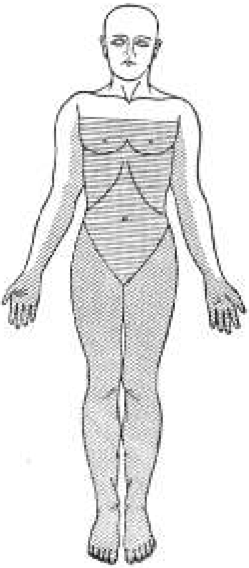

Fig. 1. Shaded Area Shows the Extent of the Sensibility Disturbance.

The autopsy was held within a few hours of death. It was found that both arches of the fifth cervical vertebra were fractured at the point of juncture with the articular processes and that they were easily movable. Around their broken ends was a slight degree of hemorrhagic exudate. All other vertebræ were intact. On opening the spinal canal, there was no narrowing at the point of fracture. The cord was swollen and for a distance of about 15 mm. filled the canal tightly. The dura mater here had a slight transverse fold, evidently marking the point where the cord had been directly injured. On opening the dura, the sixth and seventh cervical segments were a little larger and softer than those adjacent.

The brain showed no gross abnormalities.

The chief findings in the internal organs were: Acute hyperemia of the spleen; multiple small abscesses of both kidneys; pyelitis; cystitis.

The material from which the following descriptions were made was prepared by the method of Marchi (Fig. 2). But, in addition, preparations were made by the method of Weigert, and by methods to demonstrate the cell structure of the horns.

The seventh cervical segment presented the appearance of severe injury. Its contour was somewhat distorted and various areas of blackening showed the presence of degenerated fibers.

On the right side the anterior horn appeared a little crushed and both anterior horns were dotted with black. In the anterior commissure were blackened fibers and on both sides the anterior roots were degenerated and their course was marked by blackened streaks. With nuclear stains, the cells of the anterior horn, except the anterior mesial group, presented the characteristic picture of the axonal reaction. The posterior horns did not appear injured. In the anterior columns of this segment there were scattered blackened fibers. Nowhere were these grouped in any considerable numbers, but they were more abundant in the zone bordering the anterior horns. In the lateral columns were several clumps of degenerated fibers, best marked in the upper part

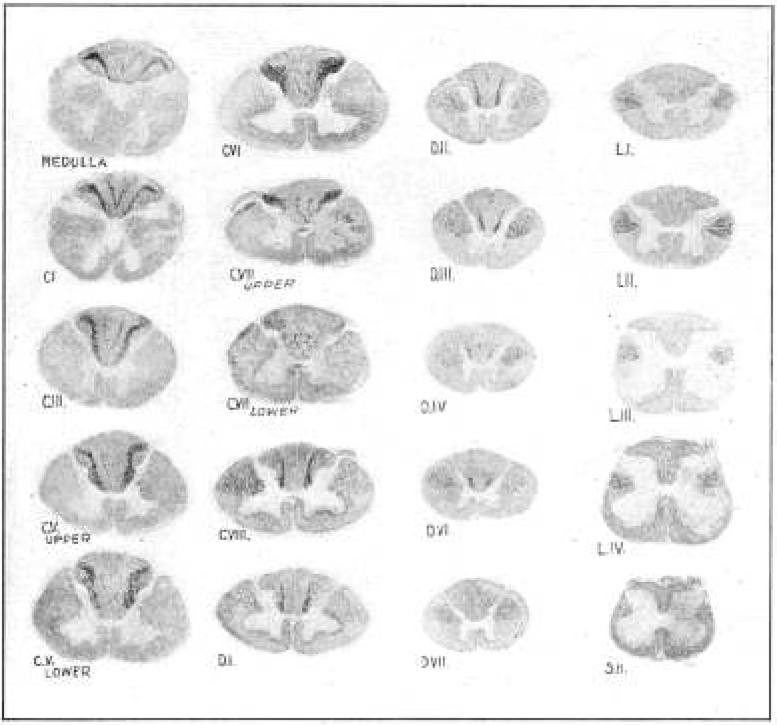

FIG. 2. Posterior column degenerations following injury of the seventh cervical segment. Above the injured segment ascending degeneration of the seventh cervical nerves. Below the injured segment descending degeneration of comma tract.

of this segment, and both lateral columns were vacuolated and showed severe injuries.

In the posterior column, instead of the common picture seen in crushing of a segment, and where the whole column was more or less filled with blackened fibers, the greatest changes were here present in the entering root fibers. In the upper part of the segment degeneration was better marked than in the lower. Almost all the entering posterior root fibers were blackened. The greater part of these curved around the tip of the posterior horn, while a few turned into the gray substance.

The sixth cervical segment showed no sign of direct crushing. Both anterior horns were sparsely dotted with black, and with nuclear stains, the cells of the horn showed the same changes as were present in the seventh segment. In the anterior commissure were a few blackened fibers. In the anterior and lateral columns the degenerated fibers lay chiefly in the regions bordering the gray substance. The entering zone of the posterior roots was thickly dotted and streaked with blackened fibers, the whole area spreading more mesially than in C VII. While the greater part of these were seen in cross section, some were arranged in streaks and were probably a part of the sixth root. The degenerations in the median part of the column were more compact and had a streak-like form.

In C V the broad club-shaped dorsal end of the degenerated zone was hollowed out on its outer side, marking the region where undegenerated root fibers had come in. The section from the upper part of the segment showed this still more marked and the area had already taken on the L shape seen in the intraspinal course of posterior root fibers. The median areas of degeneration appeared as two streaks diverging dorsally from the median septum. They lay at about the border between the columns of Goll and Burdach.

In C III the root degenerations had taken a more mesial position. The median areas of degeneration appeared much as in C V.

In C I the root degenerations had a pronounced L shape, and no longer reached the dorsal margin. The median areas were shorter, each curved a little outward, and ventrally met in the median line. In the lower medulla the root degeneration appeared much as in C I, but the median degeneration was far less marked.

Below the point of injury to the cord the eighth cervical segment showed no sign of direct injury. The anterior horns were dotted and streaked with black flecks in their outer parts, and on the right side the fibers of the anterior root which passed to the outer edge of the mesial angle were blackened. A few blackened fibers lay in the anterior commissure. The posterior horns showed a few blackened fibers extending inward from the inner angle of the horn. In the columns of the cord the antero-lateral ground bundles were sparsely dotted with black. But in the region of the lateral pyramidal tract degenerated fibers were abundant.

In the posterior columns the entering root zone showed no degeneration. Along the outer side of the paramedian septum in each posterior column was a club-shaped area of blackened fibers. Each was widest at its ventral end, where degenerated fibers extended quite up to the curving margin of the gray substance. Dorsally it tapered out a little distance from the dorsal margin. From the position of these areas and from their form they correspond to the comma tracts of Schultze.

In lower levels these tracts became progressively shorter and more tapering, and were traced into the sixth dorsal segment. The degenerations in the lateral pyramidal region were visible as low as the second sacral segment.

The foregoing case presents two interesting anatomical points: First, while the cord at the level of the seventh cervical segment was considerably injured in the anterior, and more especially the lateral regions, the injury to the posterior columns in a peculiar way involved chiefly the entering posterior roots of the seventh cervical nerve, together with a few of the fibers of the sixth, the remainder of the column showing only a small degeneration in the median part. The picture presented in Marchi preparations corresponds with the figure of the degeneration of the intraspinal part of the posterior roots, which has been described after experimental section of the posterior roots, and in a few cases of disease of the roots in their extra-spinal course, and showed the ascending course of the long fibers of the seventh and sixth cervical nerves in the posterior columns. In this course they lay entirely in the column of Burdach in about its median part, and their progressive approach to the median line in their ascending course bears out the already well-established rule of the median displacement of the posterior roots by those fibers entering in higher levels.

The only explanation which can be here offered for the peculiar and system-like median degeneration seen in Goll's column is that it is an ascending degeneration of those fibers in the middle of the posterior column which were injured at the level of the fracture. It seems strange that such an irregular and slight degeneration as is present at the level of injury should assume such a compact tract-like course as is here the case.

The second and more important feature of this case is the comma tract degeneration, and its relation to the degeneration of the posterior roots. The slight injury to the posterior columns as a whole, and the marked involvement of the entering nerve roots has an important bearing on the origin of the fibers of the comma tract, and their exogenous origin. Three opinions are maintained in the literature as to the origin of the comma tract—first, that they are of endogenous origin, *i. e.,* fiber processes of cells of the posterior horn (1); second, that they are the downward continuation of fibers of the posterior roots (2); third, that they are made of both endogenous and exogenous fibers (3).

The conditions present in this case seem to lend evidence to their exogenous origin, because of first, the marked degeneration of the posterior nerve roots as they enter the cord, and second, a lack of any significant direct injury to the posterior columns or the nerve cells of the posterior horns, none of which show the changes which are characteristic of an injury to the fiber process of a cell.

The comma tract degeneration extends to the sixth dorsal segment, and in this extent agrees with two other cases in the literature, one (1) in which the seventh cervical segment was injured and the other (4) in which the posterior root of this segment was injured, in both of which the comma tract degeneration was traced into the sixth dorsal segment.

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